The committee examined the point as to whether even the best of clocks could be depended on always to show true standard time, and, after full discussion, decided unanimously in favour of some form of control of public clocks by electric synchronisation by signals from the central time authority, and decided that the control and correction of such public clocks by hand is quite out of date and untrustworthy, and should be abolished.

The committee are given to understand that arrangements exist by which, given an electrical signal at certain specified hour or hours of the day, the hands of a clock can be automatically set to indicate the absolutely correct time, and they also understand that such arrangements can be applied to existing clocks at a very small cost.

The committee are informed that there are several distinct methods of synchronising public and other clocks.

In one, used in connection with large clocks, a slight gaining rate of the pendulum is compensated by arresting the clockwork, by means of the time signals, for the number of seconds or parts of seconds gained since the previous synchronisation.

In another method, applied to smaller clocks, the hands are mechanically set forward or backwards to standard time by an electromagnet, excited by the time signals.

It would not be difficult to provide for clocks automatically to come into circuit on telephone and private wires at stated intervals, in order that the time currents might affect the electrical controlling devices of both types referred to above, if this were thought advisable.

The utilisation of telephone and private wires used for correspondence for the synchronisation of clocks would naturally involve the suspension of their use for conversations during the short periods that they would be connected to the electrical controlling devices at the hours at which the time currents were due.

The system involves, therefore, first of all, a system of wiring for the electric signal; and, secondly, the necessary apparatus in each clock. The cost will evidently depend on the charge for the signals, the charge for the use of the wires and of the apparatus in the clocks. The first and last will be small, and the second will depend on the rate per mile charged for the use of wires.

It is obvious that as such a system for communicating electric signals already exists in the telegraphic and telephonic wires belonging to the Post Office, it would be quite unnecessary to set up an independent system of wiring for the time signals. If this is accepted, and if the synchronisation of public clocks becomes general, it is obvious that such signals must not be sent too often, and that they must be sent at a time when such wires are more or less free from the ordinary traffic. It would appear to the committee that for most purposes a single automatic signal once a day, at some convenient time of the night, perhaps at 2 a.m. or 3 a.m., would be enough, but if greater accuracy were desired more frequent signals could be made. If found necessary, signals might even be sent twice or three times a day to synchronise clocks, such as at 8 a.m. and 8 p.m., or, in addition, at 2 p.m., when in the early morning and evening the wires would certainly not be overburdened with work, but such details could be considered later on.

The question of the public or private distribution of such signals was briefly discussed, and the committee considered that any recommendation on this subject would be out of place, but they would merely point out that the initial signals giving true time must come from a public source, *i.e.* Greenwich Observatory, and there is little doubt such signals must be mainly transmitted by the wires of the General Post Office, though perhaps it is an open question whether the apparatus in the clocks themselves for utilising such signals should be a public enterprise or be done privately.

As a beginning, it would probably be well to take a few large public clocks in London and have them synchronised, and these could then be set apart and considered as "standard time clocks."

The nearest approach to a standard time public clock in London at present is probably that in the Clock Tower at Westminster. From the report of the Royal Observatory, Greenwich, read at the Annual Visitation on June 8, it would appear that the maximum error of "Big Ben" during the preceding year did not exceed three seconds, except on two occasions. This may be accepted as sufficiently accurate for ordinary purposes.

Many other public clocks, on the other hand, constantly show variations, running to minutes, and such clocks clearly should be electrically synchronised as far as possible.

Clocks like that at the General Post Office in St. Martin's-le-Grand, at the Royal Exchange, and others in large public buildings should, it is submitted, be *automatically* or *electrically synchronised*, and be considered as "standard time clocks." A few of them might be taken up as a commencement, and synchronised once or twice a day.

As most public clocks have no arrangement for showing seconds, the exact time to seconds cannot be shown on them, but as most public clocks are striking clocks, it might be arranged that the first stroke of the hour bell should be the signal indicating standard time, so that persons could tell the time accurately to a second from such signal.

It remains, therefore, to consider what can be done in the case of London in the first instance.

The following would appear to be the actions necessary to be taken by the Guild:—

(1) To approach the Postmaster-General, to ask that in the case of post offices the time signals sent to the offices should actually automatically set at least one of the clocks in each public office to standard time, and not merely indicate standard time and depend upon subsequent hand correction of the clocks, as at present.

(2) To form a deputation to the L.C.C. to ask them to have all public clocks under them, or in any way under their influence, synchronised in the same way.

(3) To take similar action with reference to the clocks under the control of the Corporation of London.

(4) To take similar action with reference to the clocks at railway stations in London.

(5) To take similar action with reference to the Office of Works, which it is believed is responsible generally for the clocks in Government departments, some of which exhibit large clocks, and which, therefore, should be synchronised.

(6) To ask the Local Government Board to take the necessary steps to secure the passing of a bye-law calling upon persons exhibiting clocks publicly to have such clocks synchronised, or, failing this, for such clocks to be done away with.

Similar action could be taken later on for provincial towns, and afterwards for smaller centres in Great Britain.

EDUCATION AT THE FRANCO-BRITISH EXHIBITION.

UNDER the chairmanship of Sir William Mather, the committee of the Education Section of the Franco-British Exhibition undertook to exhibit to the British public and our French visitors the principles and methods of our national education in all its branches and phases. So formidable a task has not been attempted heretofore in this country, and a very large amount of well-directed labour must have been spent in achieving such a great measure of success. We shall have occasion to point out certain respects in which the results fall short of the ideal; but the more closely one investigates the exhibits, the more one marvels at the thoroughness with which the display has been organised. The nearest approach from the Wood Lane entrance is through the hall of textile and chemical products, whence we enter the west end of the building (300 ft. × 200 ft.), devoted to British and Irish education. The chief decoration is a series of pleasing frescoes forming a deep frieze along three sides of the hall. These depict in allegorical form the virtues which schools seek to develop, and all have been designed by students of the Royal College of Art. We may mention that all the exhibits—with the exception of statistics and a few other administrative matters—are the work of children, students, and teachers, from the infant school to the University or technical college. The west wall is occupied by colossal maps showing the exact position of every public educational institution in the British Isles, with panels of statistics.

It appears that there is no class of the people in any district without facilities for education, but it must be admitted that the quality of these facilities is not everywhere such as to leave no scope for the reformer's zeal. Perhaps Ireland illustrates most clearly the progress made in the last decade. Prior to 1899 there was little technical education in Ireland, and in 1900 there were not more than half-a-dozen laboratories in the secondary schools. Now there are 280 laboratories, and 15,000 students are to-day being taught experimental science. There are but few secondary schools where such teaching has not been introduced. In addition, there are under the Department of Agriculture and Technical Instruction 45,000 students, and visitors will hardly fail to notice the specimens of their work which are on view; the Arts and Crafts Section being of considerable intrinsic merit.

Starting *from the west* and working towards the east end of the hall one passes from kindergarten to university. In valuing the work, especially of the young children and of the boys and girls of our elementary and secondary as distinct from technical schools, we must not lose sight of the true aim of the educator. Our judgment should be based, not on the intrinsic value or the "finish" of the exhibits, but on the extent to which their production is calculated to aid disciplined development of character, mind, and physique. From our increased expenditure on education we may look for more than improved school-attendance. We ought to find in this exhibition signs that a balanced and harmonious growth of all faculties is being encouraged by normal school-courses, apart from educational fads.

Elementary Schools.—During the last few years the improvement in infants' schools has been very great. To appreciate rightly the work of their highly competent teachers, one ought not to be content with examining the schemes of work, models, and drawings to be seen in the exhibition hall, although these bear witness to enthusiastic work. One ought also to visit an infants' school, see the conditions of work, and obtain personal experience of the skill with which modern teachers deal with the difficult task of setting drafts of babies to happy, intelligence-forming work and play. The work of elementary, higher elementary, and higher grade schools is very well displayed. We select the exhibits of the London County Council and the City of Manchester as furnishing an index to such work. We find:—(1) *Albums* which contain schemes of work, time-tables, photographs, and specimens of work; (2) *mounted illustrations* of syllabuses in drawing, science, needlework, domestic economy, wood-work, physical exercises, nature-study, geography; (3) *class-worked exercises* connected with the foregoing. The feature which impressed us most was the large share of attention given to drawing, nature-study, physical exercises, and organised games. The development of motor-activities appears to be the guiding principle. Certain of our writers and public speakers who constantly inform us that our methods are too "bookish" are under the mistaken impression that schools of to-day are still in the old grooves. A visit to the British Education Section might make them wiser and happier men. The science, domestic, and art teaching is of the type which calls upon the pupil to take an intelligent share in the work, and to employ his or her inventive powers. Presumably less time is given to reading and spelling in the first stages; but we did not observe any resulting defects in the later work. Rather we think that there is a better power of expression in the higher standards; probably the result of improved general intelligence, stimulated by modern methods. It should be mentioned that the housewifery is quite practical and simple, not *in nubibus*. Moral teaching is given with a straightforward dogmatism suited to the age of the children. The extent to which individual ability and self-reliance are being encouraged in the schools is most creditable when the conditions of work are considered.

In the higher elementary schools the study of physics is encouraged. Geography makes a good show; especially worthy of notice is the geography scheme of Basnett School, Battersea. Modern methods, based on regional survey, have been successfully applied in a district which at first sight appears to offer drawbacks rather than facilities. Despite the fact that history receives more attention than formerly, the utility of charts, pictures, &c., seems underrated. There is little evidence in this exhibition of "the appeal to the eye" in connection with history teaching in elementary schools.

County Organisation.—This is clearly exemplified in the cases of Essex, Warwickshire, and Northamptonshire, which afford good examples of decentralised administration with especial reference to local needs and industries. The combination of counties to permit interchange of teachers and scholars for the purpose of training or to form other centres of higher education is still to a great extent an unfulfilled aspiration. Perhaps the next great exhibition will be able to illustrate useful results from the working of neighbouring authorities in association. The Essex authorities have furnished much useful information as to the cost of salaries, buildings, and school supplies generally.

Public Schools and the older Universities.—The deepest matters of education have to do with "things unseen," and it does not follow that Oxford does less for the nation than a domestic economy or engineering school because the products of the latter institutions bulk more largely at Shepherd's Bush. So far as Oxford and Cambridge are concerned, we must thank those responsible for their interesting display of portraits, relics, and models, and the copious supply of photographs and official publications. Perhaps this was all that could be done; one cannot "allot space" to the spirit of a university. But something more ought to have been done to furnish visitors with a concept of that characteristic institution, an English Public School. At least, the committee ought to have acquired a model of buildings, playing-fields, &c., such as are to be found in the all-round equipment of our public schools, and are not to be found in any other country in the world. (We remember a model of Rossall School which created great interest some seven or eight years ago.) A critical observer will find much worth attention in the portfolios and exercise books. They show the actual everyday work of the boys. The pursuits of their leisure hours are copiously illustrated.

London University and the newer Universities.—Special handbooks are issued by the London University and by the deans of the metropolitan schools of medicine. We do not think that so clear and concise a statement of the multifarious activities of the University had been published hitherto. The illustrated guide to the medical schools is a good-sized volume, full of interest to all concerned in medical education. It is important to observe how the opportunities for clinical study and research are being extended, and that these opportunities are appreciated by large numbers of qualified men. The movement for promoting social intercourse among undergraduates by athletic clubs and halls of residence is gaining ground. Victoria and Sheffield Universities are strongly represented on the technological side. We are interested by a photograph taken at the Mason College, Birmingham, where the lecturer is seen addressing a theatre crowded with working men. There is room for more of this kind of university extension.

Girls' Education.—Nothing is more clearly shown than the strides made in the education of girls, especially in domestic subjects. Neither in the elementary nor in the secondary and high schools is to be found unreasoned imitation of boys' education. The work shown by the Cheltenham Ladies' College and by the Manchester High School is of a high standard, the humanities being well cared for.

Technical Instruction, Fine Arts, Arts and Crafts occupy an important place. The difficult task of selecting really typical work from the technical schools of the country was performed mainly by the Association of Technical Institutions. A display of real educational interest is the result. The growth of organised instruction in the different branches of industrial work is well evidenced by the exhibit of the City and Guilds Institute. The students' work in the fine arts and arts and crafts compares not unfavourably with the corresponding trade exhibits in other halls of the exhibition.

Music.—The weak spot in the exhibition is that the claims of music have not been recognised. The Guild of Church Musicians furnishes the only exhibit we dis-

covered. A hall for demonstrations and lectures has just been erected, and we ventured to suggest that demonstrations of school-music would be welcome.

Special Institutions.—The work that is being done in schools for the blind, the deaf, and the mentally defective calls for respectful acknowledgment. Cases showing what is being accomplished, so far as material products are concerned, can be seen near the entrance. The moral benefit to the pupils cannot be expressed.

It reflects credit on the committee and the secretaries that the whole of this wonderful collection was in place at the opening of the exhibition. The objects are displayed in an admirable manner, and furnish innumerable suggestions of value to the practical teacher.

French Education Exhibit.—Although not large enough to furnish grounds for comparison of French with English organisation of education, the French section contains many interesting features. It is housed in the corridors between Shepherd's Bush and Wood Lane, unfortunately rather distant from the English section. The *Écoles Professionelles, l'Enseignement Technique*, and the *Ecoles Primaires Supérieures* contribute; Lille, Toulon, St. Etienne, Nîmes, Dupuy, and Rouen are represented.

Much of the manual work is excellent, and teachers of chemistry may glean some useful hints from the apparatus and diagrams, which are clearly displayed. There has been an attempt to introduce some really artistic adornment into certain of our own elementary schools; but we still have much to learn in this respect. Our authorities would do well to pay attention to the charming pictures sent by the Société Artistique de l'Art à l'École. Incidentally, we observed that Arabic was included in the curricula of some pupils whose note-books we inspected.

Undoubtedly the space allotted to the French education section is too small, and hence the display falls short of our expectations. We admit that those expectations were high. In justice to the work performed in bringing together the exhibit, we should add that the interesting quality of what we could see considerably strengthened our desire for a fuller display of recent achievements by our neighbours in the field of education.

G. F. DANIELL.

THE ELECTROCHEMISTRY OF LIGHT.

IN the April and May numbers of the *Journal of Physical Chemistry*, Mr. Wilder D. Bancroft contributes two long articles under this heading, long chiefly because of the very extensive quotations from the writings of Grotthuss, Herschel, H. W. Vogel, E. Vogel, Timiriazeff, Acworth, v. Hübl, Bothamley, and others whose work bears upon the subject. The object of the communication is "to bring the various catalytic actions of light under one head so far as possible," and to show that this may be done by accepting two laws enunciated by Grotthuss some ninety years ago:—(1) that only those rays of light which are absorbed can produce chemical action; (2) that the action of a ray of light is analogous to that of a voltaic cell. The action, therefore, is regarded as electrolytic, and sensitisers, whether "optical" or "chemical," are viewed as depolarisers. The fundamental conception of Grotthuss, that the action of light is essentially electrolytic in character, is held to be sound and to accord with modern notions, though the language in which he expressed it may be somewhat obscure.

The author proceeds to show that the decomposition of various salts containing silver, iron, copper, mercury, chromium, uranium, manganese, vanadium, and molybdenum, as the result of light action yields the same products as those resulting from electrolytic action, but that some substances are light-sensitive only in the presence of a suitable depolariser (or absorber of one of the products of the decomposition). Herschel's account of his experiments on the action of light upon iron salts and ferro- and ferricyanides is quoted in full from the Philosophical Transactions. When paper is impregnated with a mixture of potassium ferricyanide and ferric chloride and exposed to light, the ferric chloride is reduced and Turnbull's blue is formed, further exposure giving a brown substance of unknown formula. The author records that since his writing Mr. Schluederberg has succeeded in producing this brown substance by electrolytic means. Herschel's observation that by the continued exposure of a Prussian-blue print to light the colour was bleached, but that the colour returned when the print was left in the dark, and that this reversal took place even when the iron salt was exposed alone and the ferricyanide added afterwards, is explained by the supposition that the light, after it has reduced the iron of the ferric ammonium citrate to the ferrous state, by its prolonged action produces a reducing agent powerful enough to reduce the ferricyanide, the white ferrous ferrocyanide that results being re-oxidised in the dark.

The analogy between the oxidation of organic bodies by the action of light and by electrolysis is not so easy to trace for want of facts. Whether the oxygen (of the air) or the dye is the depolariser must be decided experimentally in each case, and "there is one conclusive way" of answering this question. "If the active light is light which is absorbed by the substance to be oxidised and not by the oxygen, then the substance to be oxidised has been made active by the light and the oxygen is the depolariser. If the active light is absorbed by oxygen and not by the substance to be oxidised, then this latter is the depolariser, and the oxygen is made active by light. If the active light is absorbed by both, it is possible that each is made active and that each is also the depolariser. In this last case, however, the results should be checked by experiments with another oxidising agent and another reducing agent. While light can only act in case it is absorbed, it does not follow that all light which is absorbed acts to any appreciable extent." In the bromination of organic compounds, Schramm and Zakrzewski have shown that the most effective rays correspond to the weaker bromine absorption bands in the yellow-green and orange instead of the stronger bands in the greenish-blue and blue. The researches of Herschel on the action of light on the colouring matter of flowers are explicable by the Grotthuss theory, and Timiriazeff in his Croonian lecture (1903) showed the strict applicability of the law so far as regards the correspondence between the absorption of light and its chemical action in the case of chlorophyll.

In some cases the depolariser changes the sensitiveness of the system with regard to certain rays. These substances are generally distinguished as "optical sensitisers," but, the author says, "a more rational distinction would be between depolarisers with marked absorption bands and depolarisers without marked absorption bands." The discovery of the action of "optical sensitisers" by H. W. Vogel in 1873, that is, the possibility of sensitising photographic plates for the less refrangible rays by means of dyes, and Eder's work that led him to the conclusion that the absorption of silver bromide dyed with eosin and the maximum of the photographic sensitising action of eosin on silver bromide exactly coincide in the spectrum, are detailed by copious extracts from the writings of these investigators. Eder distinguished between the absorption of the dyed silver salt and a dyed gelatin film or aqueous solution of the dye, the former giving an absorption of greater wave-lengths, in accordance with Kundt's law. Acworth, who worked under apparently ideal conditions, comparing the maxima of absorption and sensitiveness by estimating them in the same emulsion, found that the sensitiveness maximum was displaced towards the red as compared to the absorption maximum, and Wiedemann accounts for this by suggesting that the light at the place of maximum absorption may cause increased vibration within the molecule, resulting in radiations or heat waves, but without the amplitude of vibration in the molecule attaining a sufficient magnitude to result in any decomposition or chemical change of the molecule. Mr. Bancroft accepts Acworth's experimental results, but considers that his absorption curves show the sum of the absorptions of the dyed gelatin film and the dyed silver bromide, instead of the absorption of the latter alone, and that therefore his results do not disprove Eder's conclusions that the maxima of absorption and photographic effect coincide.

Concerning the mode of action of such sensitisers, he states that the theory of Grotthuss enables us to make a definite statement with regard to them, "and one that differs to a certain extent from any of the previous ones.